TESTING THE HOMOGENEITY OF BRIGHT RADIO SOURCES AT 15 GHz

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A sample of radio-loud active galactic nuclei (AGN) at 2cm is studied to test the isotropic distribution of radio sources in the sky and their uniform distribution in space. The sample is complete flux-density limits of 1.5Jy for positive declinations and 2Jy for declinations between $0^\circ < \delta < -20^\circ$. The active galactic nuclei sample comprises of 133 members. Application of the two-dimensional Kolmogorov-Smirnov test shows that there is no significant deviation from the isotropic distribution in the sky, while the generalised $V/V_{\rm m}$ test shows that the space distribution of AGN is not uniform at high confidence level (99.9%). This is indicative of a strong positive evolution of AGN with cosmic epoch implying that AGN (or jet activity phenomena) were more populous at high redshifts. It is shown that the evolution depends strongly on luminosity: low-luminosity QSOs show a strong positive evolution, while high-luminosity counterparts do not seem to show any evolution with cosmic epoch.

1. The sample and results of statistical analysis

We investigate the homogeneity of the flux-density limited sample of the 2 cm VLBA[a] survey on the sky and in the space. The sample is compiled by Lister et al. (in preparation; see [1,2]) where the main selection criterion is

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[a]Very Long Baseline Array

the flux-density limit at 15 GHz; all variable sources with galactic latitude $|b| > 2.5^\circ$ and with measured VLBA flux densities exceeding 1.5 Jy (2 Jy for southern sources) at any epoch since 1994 are included in the sample. The complete sample comprises of 133 radio sources, all are active galactic nuclei: radio-loud and core-dominated. Most of them have superluminal radio jets on parsec-scales. There are 95 quasars, 21 BL Lacs, 9 radio galaxies, and 8 sources with no optical counterparts[b].

We performed a two-dimensional Kolmogorov-Smirnov test to show that the sample is distributed uniformly on the sky. The generalised version of $V/V_{\rm m}$ test [3,4] is used to show that the $\langle V/V_{\rm m}\rangle = 0.589 \pm 0.027$ which is indicative of a strong positive cosmological evolution of AGN with redshift. The BL Lacs show a similar trend, but this is not statistically significant because of the small number of sources. The distribution seems to be uniform for galaxies, i.e. with no luminosity evolution so far. The plausible explanation is that all 7 radio galaxies occupy the low redshift region where the density/luminosity evolution is negligible, but better statistics would be needed to confirm this result.

To investigate the dependence of radio luminosity on the generalised $V/V_{\rm m}$ statistic, we divided the sample of quasars in two equal subsamples above and below the absolute luminosity at 15 GHz, $P_{15} = 10^{27.9}\,{\rm W\,Hz^{-1}}$. For 46 low-luminosity quasars we find that $\langle V/V_{\rm m}\rangle = 0.658 \pm 0.036$ with the confidence level of 99.96%, indicative that the distribution of $V/V_{\rm m}$ is biased towards large values, while for 49 strong sources ($\langle V/V_{\rm m}\rangle = 0.53 \pm 0.04$, $P = 41\%$) no significant deviation from a uniform distribution is found. The K-S test shows that these distributions are different at 96% confidence level. The Student t test shows that the mean of $V/V_{\rm m}$ values for low- and high-luminosity quasars are different at high significance level, 0.011 (98.88%). The low-/high-luminosity quasars evolve differently with redshift which is indicative that the cosmic evolution depends strongly on luminosity.

References

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[b]See http://www.physics.purdue.edu/astro/MOJAVE/ for more details.